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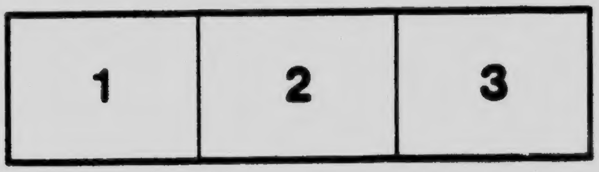

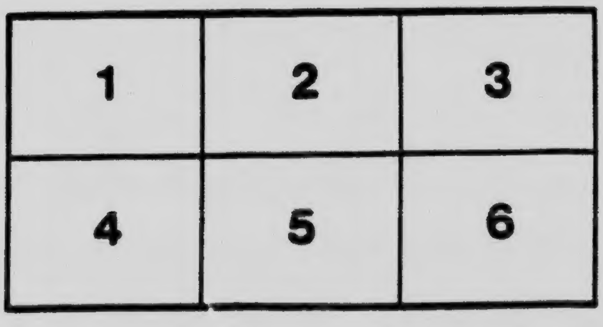

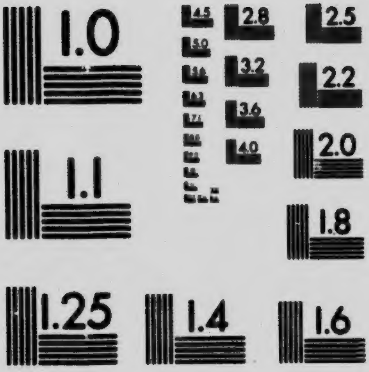

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THE ORBIT OF *b* PERSEI

BY

J. B. CANNON

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THE star *b* Persei ($\alpha = 4^{h}\ 10^{m}{\cdot}7$, $\delta = +50^{\circ}\ 03'$, mag. 4·5) was announced a binary by Professor Campbell early in 1910[*] from measures of four plates taken, two in 1903, one in 1906 and one in 1909. Its spectrum is of *A* type and a few of the plates obtained here show double lines. In the second spectrum thus appearing, the lines are not at all well defined and measures on them are only fair as will be seen by the magnitude of the residuals. The lines which show doubling are H_γ, and H_δ and in one case the iron line $\lambda 4045$.

There were taken in all thirty-six plates dating from October 10, 1910 to April 24, 1911. The lines are about the average for this type. Being a double spectrum and the two components being separable in only a few plates, the measuring is more difficult than it would otherwise be. All plates were taken with the single prism spectrograph, the length of time required for using the three prism being too great for a star of this magnitude. Seed 27 plates were used throughout for the same reason although a finer grained plate might have been very advantageous for showing doubling of lines.

The lines measured were :—

Element	Wave-Length
Hydrogen	4861·527
"	4340·634
"	4101·890
"	3970·177[†]
Magnesium	4481·400
Iron	4549·766
"	4045·975
Calcium	3933·825

[*] *L. O. B.*, V. 174.

[†] Only in one or two plates.

Other iron lines appeared in a few of the plates but for the most part were not measurable.

A table of observations follows. The phases are from corrected periastron, the residuals from the corrected curve. A table of the Lick observations is attached showing the residuals they give from the curve accepted.

Plate	Julian Day	Phase Corrected from T	Velocity (Primary)	O − C Residual	Velocity Secondary	Res.
3728	2418955·830	1·191	+ 35·4	7·6		
3738	957·760	·067	− 27·6	1·6		
3809	985·63	·445	+ 12·8	9·2		
3819	9011·72	·561	+ 41·8	+ 5·3		
3826	012·79	·114	− 36·6	− 9·5		
3854	016·72	·989	+ 51·3	− 5·2		
3862	018·73	1·472	− 8·9	+ 4·1		
3870	021·62	1·297	+ 9·2	− 16·8		
3875	022·64	·800	+ 50·7	− 3·3		
3885	027·54	1·118	+ 51·9	+ 1·4	− 81·5	− 5·0
3907	036·715	1·129	+ 59·7	+ 9·7	− 70·4	+ 1·6
3919	042·719	1·024	+ 51·0	− 5·5		
3931	049·680	.349	+ 4·4	− 2·6		
3939	053·724	1·338	+ 24·2	+ 6·7		
3949	054·792	·878	+ 59·3	+ 2·8		
3960	055·666	·225	− 10·0	+ 3·0		
3963	056·642	1·201	+ 48·4	+ 6·4		
3990	083·610	·678	+ 43·3	− 3·7	− 78·7	− 16·7
4005	088·530	1·016	+ 59·0	+ 2·5		
4017	093·510	1·414	− 3·3	− 2·8		
4018	095·490	·340	+ 5·8	± 0·0		
4031	096·530	1·379	+ 14·1	+ 2·0		
4033	097·643	·965	+ 60·2	+ 3·6		
4034	098·491	·286	+ 3·1	+ 6·6		
4057	102·549	1·289	+ 20·8	− 6·7		
4068	103·580	·793	+ 45·3	+ 3·7	− 119·0	− 33·0
4078	104·583	·269	− 14·3	− 8·3		
4087	106·542	·700	+ 55·6	+ 6·6		
4100	109·560	·664	+ 45·4	− 0·6		
4112	110·550	·127	− 22·7	+ 2·5	+ 168·8	− 28·2
4135	120·542	·955	+ 58·7	+ 2·0	− 77·3	+ 22·7
4143	124·658	·489	+ 33·5	+ 5·5		
4176	137·542	1·154	+ 47·8	− 0·2		
4185	2419138·536	.621	+ 34·4	− 7·6		
4195	141·550	·580	+ 42·1	− 4·9		
4246	151·542	1·409	+ 3·5	+ 2·5		

LICK OBSERVATIONS

Julian Day	Phase	Velocity	Residual
2416422·024	1·2092	+ 28·3	− 12·5
435·989	1·4283	− 3·5	− 0·5
7473·978	0·8397	+ 49·5	6·3
8552·017	·5908	+ 52·5	+ 12·5
960·909	·1610	− 31·4	− 9·6

The observations were combined into fourteen groups and these normal places used in obtaining, by means of Dr. King's graphic method, preliminary elements for the orbit. The normal places with mean velocities, mean phases, weights and residuals from final curve are given below.

NORMAL PLACES

	Julian Day	Phase	Velocity	Weight	Residuals
1	2419045·213	·464	+ 21·7	1	2·21
2	100·036	·590	+ 39·6	2	+ 1·04
3	099·214	·682	+ 48·3	2	+ 1·66
4	068·469	·810	+ 49·4	1·5	- 4·64
5	073·649	·961	+ 56·7	2	0·10
6	069·281	1·020	+ 55·4	1	- 0·37
7	078·533	1·137	+ 52·5	2	+ 3·41
8	018·838	1·197	+ 43·5	1	+ 0·77
9	064·280	1·312	+ 19·8	2	- 3·93
10	116·991	1·399	+ 6·0	1·5	+ 1·88
11	018·730	1·472	- 8·9	·5	+ 3·52
12	017·472	·100	- 27·3	1·5	- 0·83
13	085·016	·252	- 12·6	·5	- 3·81
14	082·780	·318	+ 4·1	1·5	+ 2·11

The preliminary elements obtained were :—

$P = 1{\cdot}52732$ days
$e = {\cdot}25$
$\omega = 150^\circ$
$K = 43{\cdot}5$ km.
$\gamma = 21{\cdot}92$ km.
$T = 2418956{\cdot}145$ J. D.

A least squares solution was carried through with the result that the following corrections were made to the elements,—

$\delta\gamma = +\ 1{\cdot}20$ km.
$\delta K = -\ 1{\cdot}925$ km.
$\delta e = -\ {\cdot}038$
$\delta\omega = +\ 0^\circ{\cdot}85$
$\delta T = +\ 0{\cdot}\mathrm{d}\ 018.$

The value of Σpvv was greatly reduced, being brought down from 241 to 128. Disagreement between computed and observation equation residuals led to a second solution being made and further corrections found,—

$$\delta\gamma = -\ {\cdot}03 \text{ km.}$$
$$\delta K = +\ {\cdot}31 \text{ km.}$$
$$\delta e = +\ {\cdot}008$$
$$\delta\omega = +\ 0^\circ{\cdot}90$$
$$\delta T = +\ {\cdot}0035 \text{ days.}$$

The new values for the elements gave satisfactory comparison between computed and observation residuals and a second lowering of Σpvv from 128 to 126.

The probable error of a normal place of weight unity was computed and found to be ± 2·5 while that of a plate of average weight was ± 3·9.

The probable errors of the elements were also computed and are given below after the final values of each.

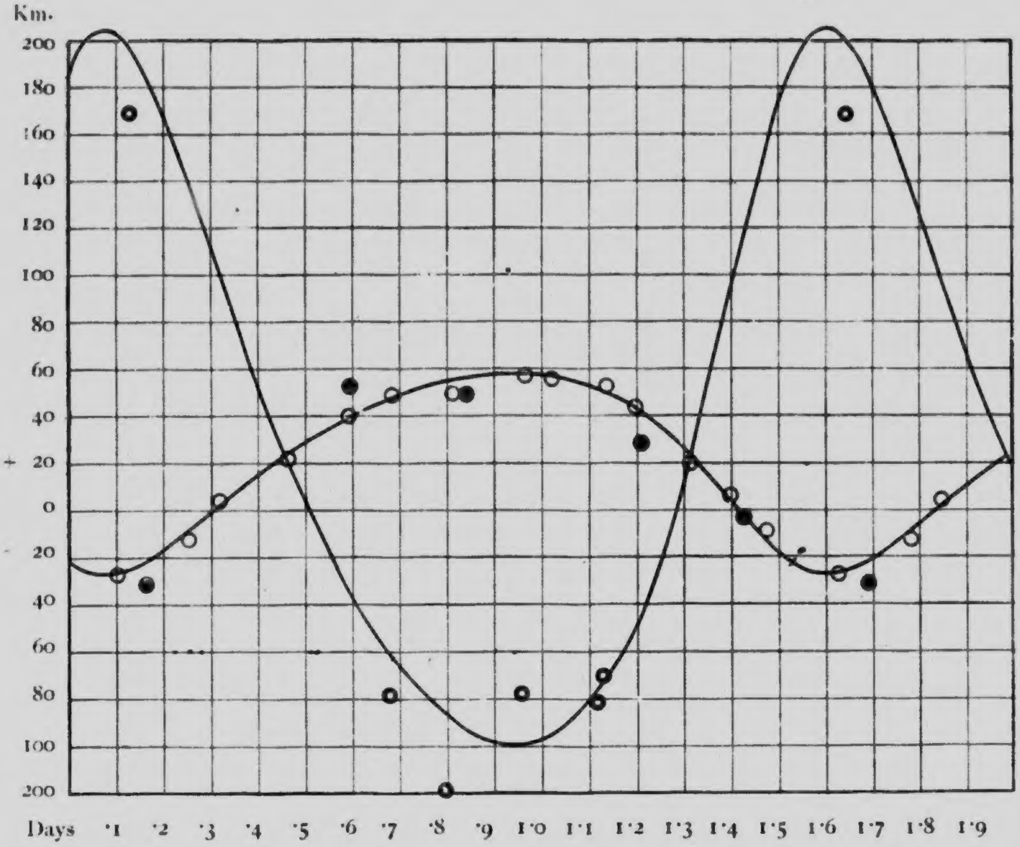
The following table gives a summary of the values of the elements preliminary, first corrected and final :—

Elements	Preliminary	First Corrected	Final Values	
P	1·52732 days	1·52732 days	1·52732 days	
e	·25	·212	·22	± ·021
ω	150°	150°·85	151°·75	± 2°·08
K	43·5 km.	41·575 km.	41·89 km.	± 0·97
γ	21·92 km.	23·12 km.	23.09 km.	± 0·57
T	2418956·145	2418956·163	2418956·166	± 0·02
$a \sin i$			837,600 km.	

Coming to the secondary, only six plates showed lines measurable. No attempt was made to get elements independently of the primary, the number of plates not being considered sufficient for that. The value of γ and T finally accepted for the primary were taken for the secondary, ω_1 taken $180^\circ + \omega$, and the K was obtained by trial graphically. Those given probably suit the six observations as well as any. The elements are :—

$$P_1 = 1{\cdot}52732 \text{ days}$$
$$e_1 = {\cdot}22$$
$$\omega_1 = 331°{\cdot}75$$
$$K_1 = 152{\cdot}5 \text{ km.}$$
$$\gamma_1 = 23{\cdot}09 \text{ km.}$$
$$T_1 = 2418956{\cdot}166 \text{ J. D.}$$
$$a_1 \sin i_1 = 3{,}048{,}000 \text{ km.}$$

The relation existing between the masses of the two bodies is given by $M : M_1 = K_1 : K = 152{\cdot}5 : 42$ or $3{\cdot}6 : 1$.



Velocity Curve of *b* Persei

The figure gives the two curves. The double circles are the observations on secondary component and the double circles with central dot are Lick observations.

I beg in conclusion to acknowledge the interest in and encouragement given by Dr. King throughout this work.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
June, 1911.